

SECTION 910—HIGHWAY LIGHTING

910.1 DESCRIPTION—This work is the furnishing, installation, erection, and wiring of the complete highway lighting system, including the electrical power supply and distribution system.

910.2 MATERIAL—

(a) Highway Lighting Material. [Section 1101](#). Submit for approval, before purchase and at no cost to the Department, catalog cuts, drawings, and manufacturer's specifications for all lighting material including lighting poles, luminaires, junction boxes, conduits, cables, and power supply components proposed for the project. Refer to the Project Office Manual for material information requirements.

(b) Other Material.

- Fine Aggregate, Type A or B—[Section 703.1](#)
- Coarse Aggregate, Type A or C—[Section 703.2](#)
- Class A Cement Concrete—[Section 704](#)
- Expansion Joint Filler—[Section 705.1](#)
- Reinforcement Bars—[Section 709.1](#)
- Nonshrink Epoxy Grout—An acceptable type.
- Nonshrink Mortar—[Section 1001.2\(e\)](#)
- Caulking Compound—[Section 705.8](#)
- Precast Concrete Products—[Section 714](#)

(c) Certification and Warranties. Secure warranties or guarantees from the manufacturers for electrical and mechanical equipment. Submit these warranties or guarantees to the Department at project completion.

Submit material certification, as specified in [Section 106.03\(b\)3](#).

For poles, submit a signed warranty from the manufacturer stating that specifications have been met.

910.3 CONSTRUCTION—As shown on the [Standard Drawings](#), as indicated, and as follows:

(a) General. Comply with local government, electric utility company, and State codes or requirements; the electrical regulations of the Department of Labor and Industry; and the construction requirements of the NEC and NESC. Cooperate with the electric utility company or agency furnishing power to the system and meet the necessary service requirements. Acquire permits as specified in [Section 107.02](#). Furnish certificates of approval from appropriate agencies when required. Upon work completion, submit to the Department five copies of "as-built" drawings, as directed, showing the date, any changes from the indicated system made during construction, and any revised circuit diagrams. Upon receipt, "as-built" drawing copies will be supplied to the agency maintaining the system. The acceptance of drawings will not relieve Contractor responsibility for erroneous or inconsistent dimensions, notations, or omissions or for the proper installation and operation of the electrical systems.

(b) Excavation for Pole Foundations. Before placing forms, each foundation excavation will be inspected for the actual soil conditions encountered. Do not proceed with work until the foundation excavation is accepted. The foundation design may need to be revised based on the actual conditions encountered as determined by the Representative.

Obtain approval of the completed foundation forms before concrete placement. Remove water from the foundation holes before concrete placement.

(c) Trench Excavation and Backfill. Remove and store topsoil encountered in the excavation. Excavate trenches for conduit runs parallel to the roadway, or as indicated. The preferred location is off of the shoulder. Backfill the same day if possible. Remove rock within the excavation unless an alternate layout is authorized. Remove and dispose unsuitable material and excess excavation as directed.

Place plastic marking tape within the last layer of backfill material for the entire length of the trench.

Provide bedding soil for conduits as specified in [Section 206.2\(a\)1.a](#). Backfill the remaining portion of the trenches with suitable on-site material to match existing conditions as shown on the [Standard Drawings](#). Do not use course aggregate, except within the subbase area or as directed. Compact trench material as specified in [Section 601.3\(f\)](#) or [Section 206.3\(b\)1](#).

Stake trench alignments for inspection and acceptance before excavating when they deviate from the indicated location. Submit the layout for review and acceptance before proceeding if the alignments extend the overall indicated circuit length by more than 5%.

(d) Pole Foundations. Construct of Class A cement concrete, as specified in the applicable parts of [Section 1001.3](#).

Before erection of high mast poles, mix, cure, and test samples of the foundation concrete according to Department procedures.

Provide and place anchor bolts perpendicular to the top plane of the foundation. Use suitable templates or forms to hold the anchor bolts in position while placing concrete.

Clean the exposed portion of anchor bolts and associated hardware.

Install individual electrical grounds for pole foundations. Install additional ground rods as required if the resistance between the pole and ground is greater than 25 ohms. Attach the ground wire to the ground rod with an exothermic weld or bronze connector. Test before placing concrete.

(e) Lighting Poles and Accessories. Install poles plumb. For other than high-mast, use aluminum shims with aluminum bases; and use stainless steel shims with other bases. Place shims under no more than three bolts of any base. Orient the handhole in the direction of traffic, unless otherwise indicated.

Plumb high-mast poles, using the leveling nuts supplied with the anchor bolts.

Unless otherwise indicated, install bracket arms at right angles to the pavement edge with arms securely fastened to the pole shafts. Install luminaires and ballasts according to the manufacturer's instructions or as indicated.

Fasten an identification plate to the roadway side of the pole 2.5 m (8 feet) above the foundation or as directed.

Select one or more poles for the static load test, as specified in [Section 1101.02](#) before erecting the remainder of the poles.

Use similar pole types and similar materials within the same general area.

Field-assemble two-piece pole shafts by overlapping bolted sections.

Do not field weld poles or accessories.

(f) Supervision (High-Mast Installations). Ensure that a manufacturer's representative is on site to assist in supervising the field assembly and erection of high-mast poles and to instruct Department personnel in the proper procedures for raising and lowering the luminaire ring and in the recommended maintenance care of the poles.

Check the pole section mating and alignment before the erection of the pole.

Request the electric utility company to be present during erection of poles within 60 m (200 feet) of their aerial electric lines.

(g) Conduits. Support conduits firmly and rigidly in place in a manner to prevent dislodging, while placing concrete or while performing other operations. If possible, install conduits under roadways before placing the pavement. If this is not possible, install a 80 mm (3-inch) diameter rigid steel conduit for a sleeve. Jack, auger, or bore under pavements, shoulders, sidewalks, railway tracks, and other indicated areas. Do not water bore. Extend this sleeve under the roadway approximately 600 mm (24 inches) beyond the outside paved edge. Place the lighting conduit through this sleeve.

Grind the cut ends of metallic conduit to remove rough edges. Do not use defective conduit. Thread steel conduit for couplings and fittings. Coat the threads as specified in [Section 910.3\(r\)](#).

Weld plastic conduit joints with solvent, according to the conduit manufacturer's recommendations.

Make conduit bends and offsets, either in the shop or in the field. Do not damage the protective coating when making bends and offsets. Do not reduce the interior diameter of the bend. Form the bend on a radius at least twelve times the conduit diameter, but not less than 460 mm (18 inches). Use manufactured sweep bends whenever possible.

Seal the ends of partially installed conduit runs if conduit work is temporarily suspended. If it is necessary to open the ends for cleaning or testing, reseal them upon completion. Seal the conduits in control cabinets.

Install conduit expansion and deflection joint fittings at each structure expansion joint as shown on [Bridge Standard Drawings](#).

Ground steel conduit and provide electrical continuity on structures, as specified in [Section 910.3\(q\)](#), as soon as possible after installation, and before energizing the system. Connect fittings, junction boxes, and other appurtenances to the conduit on a structure so electrical continuity is maintained. Provide conduit expansion joints with an external bonding jumper.

Coat underground steel galvanized conduit with bituminous paint or other approved coating if placed in a corrosive area. Use hot-dipped galvanized coating for other areas.

Clean conduit runs after installation by pulling a stiff wire brush, the size of the conduit, through the conduit. Then test the conduit by pulling a ball mandrel that has a diameter of at least 85% of the inside diameter of the conduit, through each conduit run. Where the mandrel fails to pass, either clean the conduit without injury to the conduit walls or replace the conduit.

Fasten conduits to electrical equipment using code-approved devices. Use watertight conduit fittings to connect to watertight enclosures.

Attach conduit to wood poles with 3 mm (1/8-inch) thick hot-dipped galvanized steel straps and galvanized lag screws. Provide 1.5 m (5 feet) maximum spacing between straps.

Do not install pull wires in the conduit, unless indicated.

Provide a 50 mm (2-inch) minimum direct burial conduit for underground circuits.

(h) Cable Installation. Do not damage the cable insulation. Manually remove the cable from the drum or reel. Notify the Representative when cable is to be placed. Do not proceed without the Representative being present.

Use cable grips to install the cable in the conduit. Simultaneously pull cables within a single conduit, but do not damage the cable by overpulling. Use a dynamometer if pulling other than by hand. Use pulling lubricant of a type recommended by the cable manufacturer if necessary. Use extreme care when pulling cable through handholes in pole shafts. Place a pad of firm rubber or other similar material around the bottom edges of the opening to protect the cables.

Clearly locate underground conduits with aboveground markers if guide rail or other surface features are to be constructed in the immediate area.

Provide enough slack cable in junction boxes and light pole bases to allow exterior splicing. Neatly arrange the spliced cables or coil in junction box or pole base.

Prevent the entry of moisture into the cable at all times during installation. Seal the ends of cable until final splices are made.

Make splices with pre-molded disconnectable connector kits rated for 600 V. Provide splices with a minimum watertight or splash proof seal using weatherproof boots and tape as required by the manufacturer; and when placed in junction boxes or other potentially wet areas, provide splices that are waterproof and submersible. For in-ground junction boxes use non-fusible splices, unless indicated otherwise. Use only breakaway type connectors for connections where breakaway bases are used. Line splice only at pole bases or junction boxes. Do not splice cables inside conduits.

Use seven-strand 5.26 mm² (No. 10 AWG) insulated wire for the line taps from the feeder cable to the ballast for the phase and neutral wires. Provide taps to the feeder cables as specified for line splicing. Do not use wire nuts for cable taps. Provide adequate size connectors for the wire sizes involved. Provide individual fusing for all conventional lighting. Fuse the tap with a 6A to 10A fuse, midsize, 250 V rating. Fuse the phase wire only. Connect the neutral wire to the ground wire at the pole base with a split bolt connector and coat the connection with an approved corrosion inhibitor. Attach the cable to the J hook at the pole top with a cable grip that supports the weight of the cable.

Furnish and install circuit-identifying tags on control and distribution circuit cables where they connect to equipment located in service cabinets and vaults and on cables in junction boxes and pole shafts. Use fiber or other acceptable nonconducting tags, not less than 20 mm (3/4 inch) in diameter, and not less than 0.8 mm (1/32 inch) thick. Legibly stamp identification markings on the tags using small tool dies or permanent, waterproof marker. Securely tie each tag to the proper conductor, using plastic or nylon cord.

Use underground cable in direct burial conduit for all underground installations. The minimum underground wire size is 8.38 mm² (No. 8 AWG) copper cable.

(i) Cable Duct. Use only if indicated. Install similar to conduits as specified in [Section 910.3\(g\)](#), and according to the manufacturer's instructions.

(j) Luminaires. Check the luminaires for the proper lamp socket position, according to the lamp distribution indicated, before placing on the pole top or arms. Uniformly adjust and level luminaires.

Immediately before the illumination test, and after the other work has been completed, clean the light control surfaces according to the luminaire manufacturer's recommendations using a cleaner recommended by the manufacturer.

Provide luminaires with a weather resistant decal that shows the lamp wattage. Provide a decal that is visible from the ground.

(k) Service Pole Installation. Position the service pole inside the right of way, and where indicated. Mount a meter base on the pole according to the utility company's requirements. Coordinate the meter installation with the utility company.

Install poles, according to the current specifications and standards of NELA, EEI, and NESC. The minimum depth of holes for setting wood poles 9 m to 12 m (30 feet to 40 feet) in length is 1.8 m (6 feet), measured from the low side on sloping ground. Dig holes with vertical sides and with a diameter large enough to permit use of a mechanical tamper around the pole. Ensure that each pole is inspected and accepted before backfilling. Deposit acceptable backfilling material around the poles and mechanically tamp, in layers of not over 100 mm (4 inches). Place backfill material around the pole to drain water away.

Guy service poles, if necessary. Install cone anchors 2.1 m (7 feet) below ground level. After placing the anchor, backfill the hole with coarse aggregate for a depth of 600 mm (24 inches) above the anchor, then tamp during backfilling. Backfill the remaining hole with the excavated material, then thoroughly tamp. Obtain approval for the guys before the conductors are strung. Install a guy guard if the guy is adjacent to the roadway.

(m) Photoelectric Control Device. Use a plug-in device, for ease of replacement. Install the device with its detector area facing north.

(n) Enclosure Installation. Mount enclosures for housing the control equipment. Padlock the enclosures. Key as directed. Provide enclosure ID tags as specified for pole ID tags. Provide the power supply number and the system voltage on the tags.

(p) Junction Boxes. Obtain acceptance of any change in box location before installation.

Excavate, then construct or install the box. Backfill around the box and dispose of excess or unsuitable material. Ground the junction box as required.

If using precast junction boxes with knockouts, remove the knockouts, then tightly grout the conduit or conduit sleeves in place with nonshrink mortar.

Ground exposed metal parts of junction boxes with a minimum 21.15 mm² (No. 4 AWG) ground wire and a minimum 12 mm x 2.5 m (1/2-inch by 8-foot) ground rod. Connect the ground wire to the ground rod with either an exothermic weld or with a bronze connector clamp. Connection to an adjacent system ground rod is allowable.

(q) Grounding.

1. General. Install individual ground rods. Install additional ground rods as required if the resistance to ground is greater than 25 ohms. Attach the ground rod to the ground wire with an exothermic weld or a bronze connector. Coat bronze connection with approved corrosion inhibitor.

2. Grounding on Structures. Ground lighting poles, underpass luminaires, and metal junction boxes on structures by connecting to the structure mounted steel conduit. If using structure mounted non-metallic conduit, use a continuous grounding conductor in the conduit.

Do not connect the neutral to the ground on structures.

Provide one ground rod for structures up to 150 m (500 feet) in length. Provide one ground rod at each end of structures over 150 m (500 feet) in length. Ground structure mounted steel conduit with a 21.15 mm² (No. 4 AWG) uninsulated copper ground conductor. Provide a separate insulated or uninsulated continuous ground conductor of the same size and material as the circuit conductors for structures using non-metallic conduit. Install the ground conductor with the circuit conductors. Connect the ground conductor to the ground rod(s).

(r) Galvanize Repair. Repair field damage to any galvanized finishes by painting with two coats of Zinc Dust-Zinc Oxide Paint, according to ASTM A 780, or with an acceptable equal.

(s) Power Supplies. Make arrangements with the local electric utility company for electrical service for the lighting system.

Furnish and install the specified number of wooden poles for the power supplies with the necessary auxiliary equipment (crossarms, brackets, meter base, transformers, cutouts, lightning arresters, conduit, insulators, switches, fuses, circuit breakers, contractors, photoelectric controls, enclosures, weatherheads, service wire, guywire, and grounding) to provide complete electrical service for the entire lighting system.

(t) Buried Cable and Conduit Markers. Set the markers flush with the ground and directly over the trench. Place the marker directly under the guide rail when trench and guide rail cross.

(u) Tests. Perform the following tests as applicable and record the test data on the test forms. Provide the electrical energy and furnish personnel and equipment to complete the tests. Correct any defects disclosed by the tests and then retest the corrections. Perform the tests in the presence of an authorized representative of the Department.

Form	Title
CS-4225A	Ground Rod Test
CS-4225B	Conductor Insulation Resistance Test
CS-4225C	Circuit Performance Test
CS-4225D	Highway Illumination Test (Conventional)
CS-4225E	Sign Illumination Test
CS-4225F	High Mast Lighting Test
CS-4225G	Static Load Test (Conventional)

Satisfactorily demonstrate that circuits are continuous and free from short circuits and from unspecified grounds. Provide a resistance to earth-ground, for each ground rod installed, of not more than 25 ohms. Supply and install additional ground rods until this requirement is met or as directed.

The resistance to ground of conductors for direct buried cable is to be as shown in Table A at 15.6 °C (60F), when measured with a 1000 V megger:

TABLE A (Metric)
Insulation Resistance (Megaohms- minimum, based on 305 m)
Wire Size (mm²)

Cable Type	5.23-13.3	21.1-42.5	53.4-67.5
Cross-Linked Polyethylene RHW, RHH, USE	2000	1500	1300
Cross-Linked Polyethylene XHHW	1600	1100	900
Rubber-Neoprene RHW	500	350	300
PVC THW	140	120	100

TABLE A (English)
Insulation Resistance (Megohms- minimum, based on 1,000 feet)
Wire Size (AWG)

Cable Type	10-6	4-1	1/0-2/0
Cross-Linked Polyethylene RHW, RHH, USE	2,000	1,500	1,300
Cross-Linked Polyethylene XHHW	1,600	1,100	900
Rubber-Neoprene RHW	500	350	300
PVC THW	140	120	100

Take voltage readings, with load and without load, at the power supply side of the control cabinet main breaker. The readings with load must be within $\pm 5\%$ of nominal voltage (typically either 120 V or 240 V). Take voltage readings at the last light of each circuit. A voltage reading is acceptable if it is within 5% of the reading with load at the supply point.

Take current (ampere) readings with a full lighting load on the load side of each distribution breaker in the control cabinet. A current reading is acceptable if it does not exceed 75% of the breaker rating.

Energize and operate the lighting system, including automatic control(s), for 168 consecutive hours. At each control cabinet, supply a service voltage graphic record covering the test period, with the installed electrical equipment in normal operation (lights on at night and off in daytime).

After the lights have been energized for at least 100 hours burning time, and after dark, take horizontal lux (footcandle) readings at road level with the light meter leveled. Use a light meter conforming to the following:

- Lowest full scale not exceeding 21.5 lux (2.0 footcandles) or equivalent sensitivity.
- Calibrated by a recognized testing laboratory within the past year and bearing the certification of calibration.

Take lux (footcandle) readings, where directed. Give particular attention to points where low illumination is most likely to occur, usually midway between luminaires.

Complete the static load tests specified in [Section 1101.02\(a\)1](#).

Lower and raise the ring assembly of all high mast poles to ensure proper operation.

(v) Guarantee. Guarantee the in-service operation of all mechanical and electrical equipment, and related components of the entire lighting system including lamps, for a period of 180 days. The guarantee begins the day after the lighting system is fully operational, as determined by the Representative, after completion of all lighting system related work and completion of the 168-hour performance test specified in [Section 910.3\(u\)](#).

The energizing cost during the guarantee period will be borne by others. Perform the following at the onset of and during the guarantee period:

- Execute the in-service guarantee notification [Form CS-4225H](#), provided by the Department.
- Commence repairs within one calendar day following notification to the person designated on [Form CS-4225H](#).
- Guarantee all repairs and material replacements for the balance of the guarantee period, or 30 days, whichever is the longer period.
- Repair work not performed within the guarantee period, or any extension periods, will be considered latent defects as specified in [Section 107.16\(b\)](#).

Repairs that are the direct result of external causes will be performed by others. Examples of external causes are lightning strikes, vehicular impact, objects driven through the underground circuit, trenching through installed circuits, etc.

Issuance of certificate of acceptance or final settlement of the contract is not consequential to the in-service guarantee period described herein. The guarantee period is not a part of the contract time.

910.4 MEASUREMENT AND PAYMENT—

(a) Junction Boxes. Each, for the type indicated.

The price includes the ground wire, ground rod, ground clamp, and necessary excavation and backfill.

(b) Poles (Conventional). Each, for the type and height indicated.

The price includes either frangible or breakaway base (when indicated) and arm.

(c) Poles (High-Mast). Each, for the height indicated.

The price includes the lowering device and wiring from the line splice to the luminaire ring.

The winch drive unit is incidental to the total number of poles constructed.

(d) Arms. Each, for the length indicated.

The price includes complete installation.

(e) Luminaires (Conventional). Each, for the wattage and mounting indicated.

The price includes complete wiring from luminaire ballast to line splice.

(f) Luminaires (High-Mast). Each, for the wattage indicated.

The price includes complete wiring from the luminaire-ring terminal board to the luminaire ballast.

(g) Luminaires (Underpass). Each, for the wattage and mounting indicated.

The price includes complete wiring, conduit, and necessary mounting provisions from the line splice at the junction box to the luminaire.

(h) Ballast. Each, for the wattage indicated.

The price includes mounting and wiring, as directed.

(i) Pole Foundations. Each, for the type indicated.

The price includes excavation, concrete, anchor bolt assemblies, reinforcement bars, conduit, ground rod, ground rod clamp, grounding conductor, backfilling, and satisfactory disposal of surplus material.

(j) Cable and Conduit Markers. Each

The price includes excavation, concrete, backfilling, and satisfactory disposal of surplus material.

(k) Conduit. Meter (Linear Foot)

The price includes fittings, expansion/deflection fittings, joints, bends, grounds, protective coatings, and appurtenances. Does not include conduit in pole foundations.

Unless otherwise authorized, no allowance will be made for additional conduit lengths as a result of deviation from the indicated conduit location.

(m) Cable. Meter (Linear Foot)

No allowance will be made for coiling or looping cable slack lengths inside pole bases or junction boxes, when additional lengths of cable are necessary for splicing. An allowance will be made for cable entry into each pole base from the trench to the handhole.

Unless otherwise authorized, no allowance will be made for additional cable lengths, or cable size, as a result of deviation from the indicated cable location.

The ground wire and ground rods specified for structures are incidental to the circuit cables. Splices and fuses are incidental to the circuit cables.

(n) Trenches. Meter (Linear Foot)

The price includes excavation, backfilling, temporary and permanent plastic trench markers, and surplus material disposal. No allowance will be made for rock excavation or for any other subsurface condition encountered.

Unless otherwise authorized, no allowance will be made for additional trench lengths as a result of deviation from the indicated trench locations.

(p) Pull Wire. Meter (Linear Foot)

When indicated.

(q) Complete Power Supply System. Each

The price includes service pole and all necessary power supply equipment.

(r) Testing of Entire Lighting System. Lump Sum

The price includes furnishing personnel, equipment, and electrical energy necessary for tests.

(s) Conduit Sleeve. Meter (Linear Foot)

The price includes all work necessary to install the conduit sleeve as specified in [Section 910.3\(g\)](#). The price does not include circuit conduit passing through the sleeve.